

# Thoughts about PXIE MEBT in FY15

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November 26, 2013



- This is a suggestion of how we can proceed after installing and RF-commissioning the RFQ in FY15
  - In this report, everything downstream of RFQ (in FY15) is referred as MEBT
- The list of measurements in the following slides is not likely to fit into FY15; it is more a possible plan of actions
  - Hopefully, it can be used for more detail discussions and eventually designing of necessary components
- Part of the discussion is validity of assumptions (next slides)



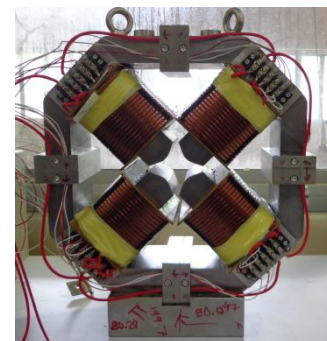
- The PXIE goal stays to test critical elements of the front end of a CW SRF linac. For the warm part It includes:
- LEBT with the required features (not discussed here)
- Test of the CW RFQ
  - Tuning, reliability
  - Beam characterization
- Development and testing of a wideband chopping system
  - Absorber
  - Kickers
  - Drivers
  - Corresponding LLRF and diagnostics
- Vacuum system compatible with transition to SRF
- Development of diagnostics, controls, MPS etc.
- **Scenario for the coming couple of years should take into account that details of the goals may change**



- FY15 budget for the MEBT is assumed to be at the same level as FY14
  - Minor variations in the budget are not likely to change the plan
    - Less money means delays
  - More money will change for FY15 only details, for example
    - Add an emittance scanner
    - Full set of new BPMs
    - 21 kW absorber instead of a prototype
  - However, the FY15 budget will affect our success in FY16



- In March 2015, RFQ is RF-commissioned and ready for the beam
- By that time, LEBT is ready
  - Pulsed and DC modes up to 10mA; elements of MPS
- MEBT components
  - 4 F-quads (two doublets) are manufactured and measured
    - The quads are assumed to be manufactured by BARC, India
    - Expected delivery date is April 2015
  - Bunching cavity prototype is successful and can be used
    - A 162.5 MHz driver is purchased
  - 4 new BPMs are ready to be used (or 2 new + 2 from HINS)
  - A reliable absorber prototype (5 kW) is ready
  - 50 Ohm and 200 Ohm kicker prototypes are ready
  - “a drive” is available for each kicker (see later)
  - 2 scraper assemblies (4 scrapers each) are ready
  - HINS elements are retrofitted for using at PXIE (see in next slides)

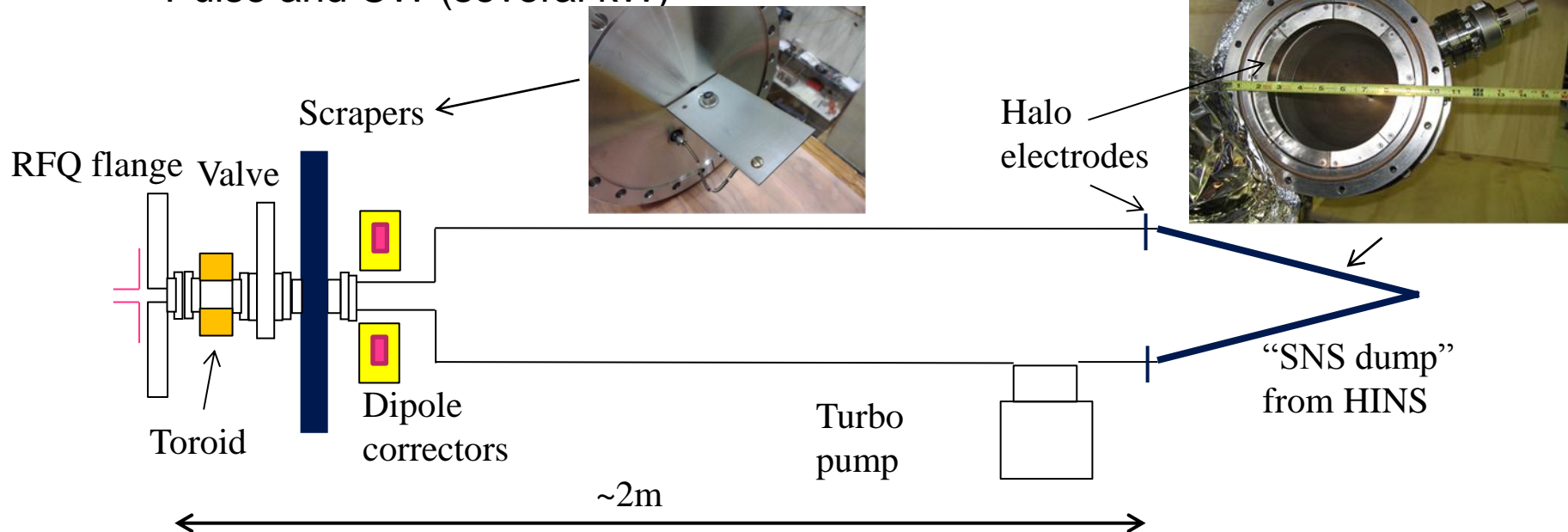




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- testing the CW RFQ and elements of the CW chopping system makes sense independently on the scheme of “Injector-2”
  - Preliminary characterization of the beam out of RFQ
  - Testing of an absorber prototype
  - Preliminary testing of kickers
  - Development of diagnostics, controls, LLRF, MPS
    - Details on the following slides

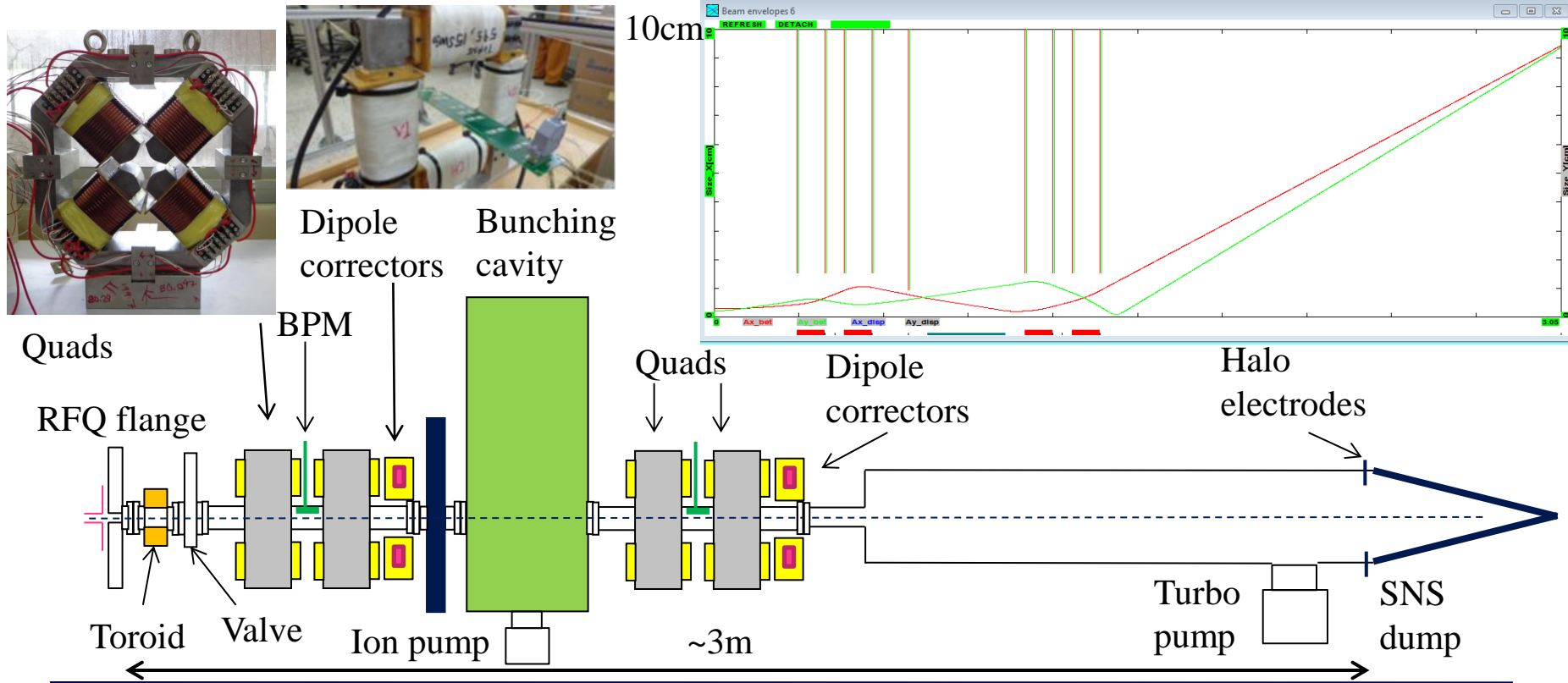


- Stage 1: first beam current, loss in RFQ, estimation of divergence
  - Quads are not likely to be ready at this time
  - Toroid (identical to LEBT's)
  - 4 electrically isolated scrapers (need to be designed);  $\sim 50$  W/jaw
    - Will try to re-use Ecool's linear drives + TZM plates
  - Pulse and CW (several kW)





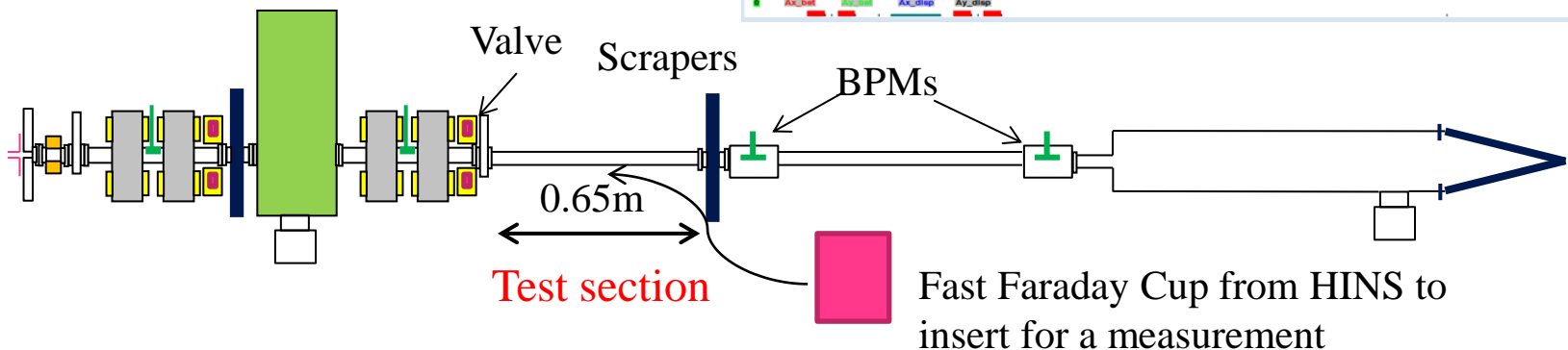
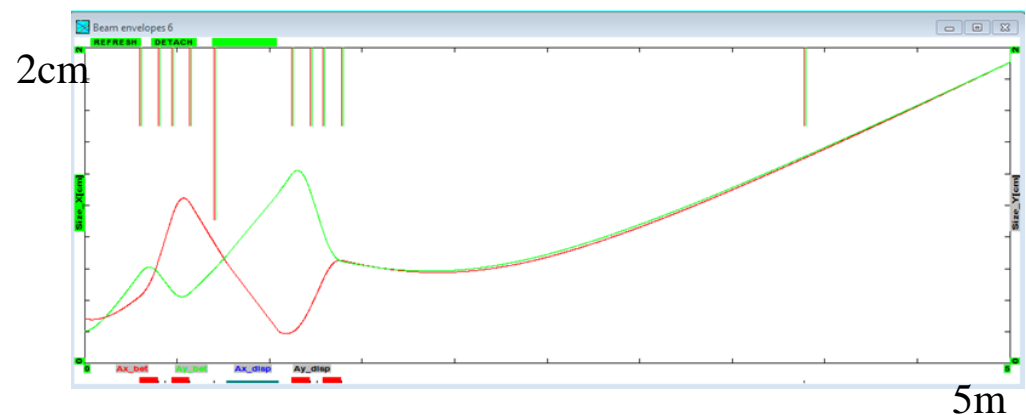
- Stage 2: CW beam  $> 10\text{kW}$ ; estimation of energy; MPS
  - First section of MEBT in its final version
    - 2 doublets, 2 dipole corrector sets, 2 BPMs





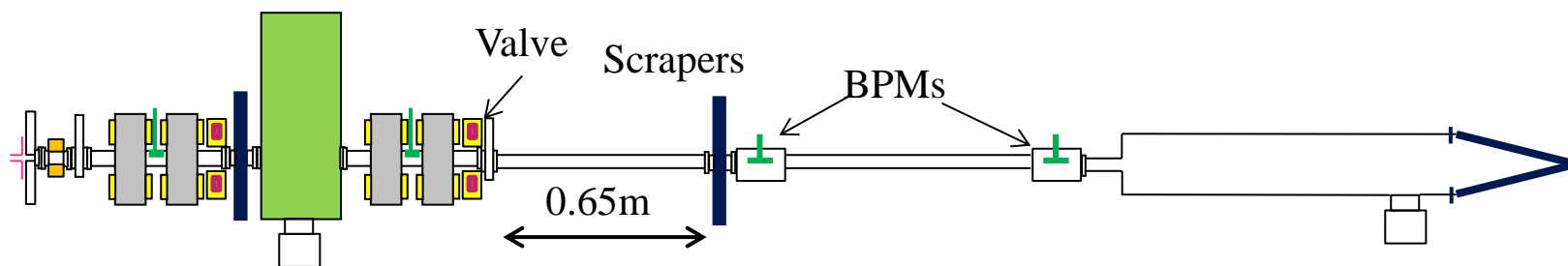


- Stage 3: energy measurement; estimation of emittances
  - Test section where equipment can be easily replaced without moving other parts
  - 2 more BPMs (may be HINS'); 1 more scraper assembly
  - Transverse emittance
    - scrapers+ quad scan
  - Longitudinal emittance
    - Fast Faraday Cup from HINS + buncher scan
  - Pulse mode only



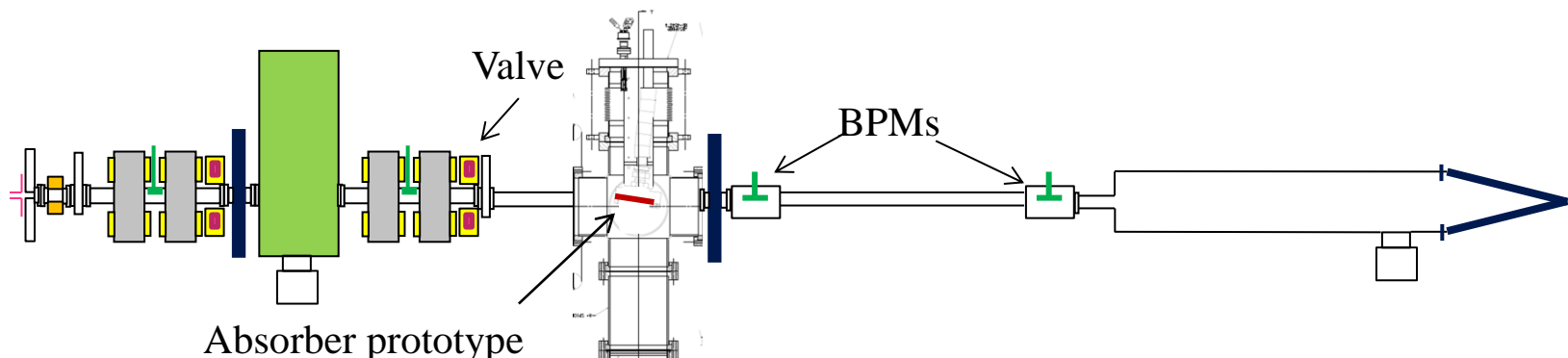


- At the same time, the optics of the first section will be characterized
  - Quadrupole scans; trajectory response to dipole kicks
    - Using beam positions measured by BPMs
  - Bunching cavity characterization
    - Using phases measured by BPMs and the HINS' Fast Faraday Cup
- These stages requires development of BPMs, LLRF, MPS



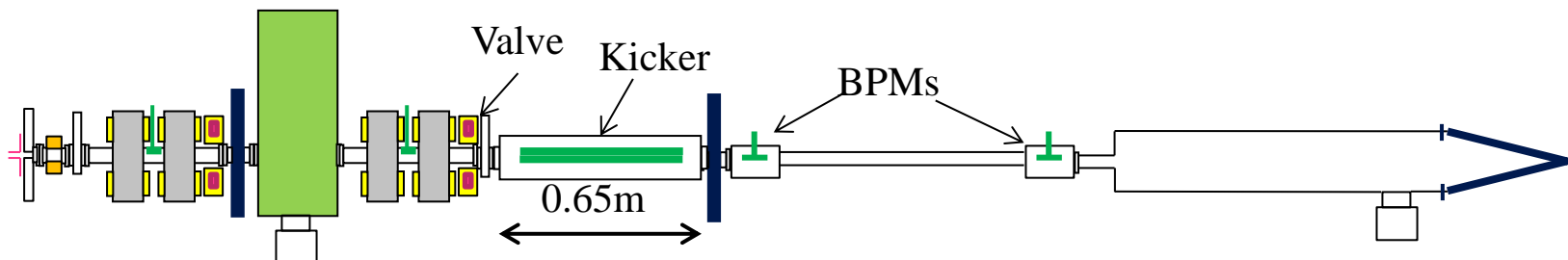


- In the “nominal scenario”, only the absorber prototype will be tested in FY15
  - We hope to design, manufacture, and test with e-beam the second, more robust version of the prototype in FY14
    - Testing of thermal properties , thermocycling, diagnostics...
  - Install the prototype using the can as well as pumping, and optical systems from the electron beam test stand
- The main goal is to test blistering and sputtering with H- beam of the representative density





- In this scenario, the kickers will be tested for
  - Electromagnetic properties
    - Measured by BPMs downstream
    - Estimation of the phase velocity: kick strength as a function of energy, varied by the bunching cavity
    - Kick at a given driver voltage
  - Operational properties
    - Survival with irradiation by beam tails
    - Vacuum properties with a beam
    - Machine Protection System
- Drivers – see in the next slide





- 50 Ohm kicker
  - Rent amplifier(s) similar to that used for testing of the driver's concept
    - 150W amplifier gave ~200V ptp
    - Two such amplifiers (one per plate) should give ~3 mm shift in the last BPM
    - Should be accurately measurable with an oscilloscope
- 200 Ohm kicker
  - One 100 V driver prototype has been successfully tested
    - Already enough for a measurable deflection
  - Hopefully, two 500 V drivers with characteristics close to FRS will be ready by that time
    - Would be capable for a full - parameter test



- With the MEBT budget FY15 similar to FY14's, we should have enough equipment to make meaningful measurements
  - RFQ characterization in a reduced scope
    - No maximum power test (~10 kW instead of 21kW)
    - No phase portrait measurements
    - Only estimations for longitudinal emittance
  - Tests of the chopping system components
    - Prototypes of absorber and kickers
    - Not a direct demonstration of the bunch-by-bunch selection, but the tests should give a reliable prediction
  - Commissioning of all infrastructure
  - Making foundation for FY16 may need more funds
- Components discussed in this plan need to be tested for the present version of PIP-2 (CW – compatible 2mA linac for Booster injection)
  - I feel that the FY15 plan may be independent on details of PIP-2 development